IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of

DANIEL R. BLAKLEY HP Docket No. 200206025-1

Serial No. : 10/632,290 Examiner R. Miller

Filed : July 31, 2003 Group Art Unit 2856

For : MULTIPLE-TRANSDUCER SENSOR SYSTEM AND METHOD WITH SELECTIVE ACTIVATION AND ISOLATION OF INDIVIDUAL TRANSDUCERS

Commissioner for Patents
P. O. Box 1450
Alexandria, Virginia 22313-1450

Sir:

DECLARATION UNDER § 1.131

I declare as follows:

1. I am an inventor who, on July 31, 2003, filed the above-identified application. At the time of such invention, I was an employee of Hewlett-Packard Company.

2. Prior to September 30, 2002, the effective date of the application from which Patent Application Publication No. 2004/0064051 published, I conceived of my invention, and diligently worked toward reducing my invention to practice, as demonstrated by the Invention Disclosures attached to this declaration as Exhibit 1.

3. At the time of preparing Exhibit 1, which preceded September 30, 2002, I had conceived of a transducer-based sensor system, comprising: a transducer array including a plurality of transducers, where at least one transducer in the transducer array is configured to have a sample material attached thereto; an output processing subsystem coupled with the transducer array; and a selector

coupled with the transducer array and configured to selectively activate transducers within the transducer array by applying an enabling signal to the transducer array for at least one, but less than all, of the transducers, such that the transducer array includes at least one selected transducer and at least one unselected transducer, where: for a selected transducer, application of the enabling signal enables a transmission path between the selected transducer and the output processing subsystem, thereby permitting output signals to be transmitted from the selected transducer to the output processing subsystem; and the transducer array is configured to isolate any unselected transducers from the output processing subsystem, where such isolation is obtained by disabling the transmission paths, thereby substantially preventing output signals from being transmitted from the unselected transducers to the output processing subsystem.

4. I also had conceived of a transducer-based sensor system, comprising: a transducer array including a plurality of transducers configured to be placed into operative proximity with a sample material, and configured to produce electrical output based upon drive signals applied to the transducers and upon the sample material, where at least one transducer in the transducer array is configured to have a sample material attached thereto; an output transmission path associated with each transducer, each output transmission path being defined between its associated transducer and an output processing subsystem configured to receive electrical output from the transducers; and a selector configured to control activation and deactivation of portions of the transducer array by enabling and disabling the output transmission paths such that each output transmission path is either enabled, thereby allowing transmission of electrical output from the respective transducer to

the output processing system, or disabled, thereby preventing transmission of electrical output from the respective transducer to the output processing system.

5. I also had conceived of a transducer-based sensor system, comprising: a transducer array including a plurality of transducers and means for producing electrical output based upon drive signals applied to the transducers, where at least one transducer in the transducer array is configured to have a sample material attached thereto; output processing means for receiving and processing electrical output from the transducer array; an output transmission path means associated with each of the plurality of transducers, each output transmission path means being defined between its associated transducer and the output processing means; and selector means for selectively activating and deactivating portions of the transducer array by enabling and disabling the output transmission path means such that each output transmission path means is either enabled, thereby allowing transmission of electrical output from the respective transducer to the output processing means, or disabled, thereby preventing transmission of electrical output from the respective transducer to the output processing means.

6. I also had conceived of a method of performing sensing operations on a sample using a transducer array having a plurality of transducers, the method comprising: attaching the sample to at least one transducer in the transducer array; operating the transducer array sequentially through a plurality of different states, where the method includes, for each state: activating one or more of the transducers within the transducer array, which includes applying a drive signal to the transducer and receiving a corresponding output signal for the transducer at an output processing subsystem; and isolating all non-activated transducers within the

transducer array to inhibit coupling of noise contributions from the non-activated transducers to the output processing subsystem, where the transducers which are activated are varied from state to state as the transducer array is operated through the plurality of different states, thereby permitting output to be obtained for different portions of the transducer array at different times.

7. I also had conceived of a method of employing an array of transducers to perform a sensing operation on a sample material, where the transducers are operatively coupled with an output processing subsystem configured to receive electrical output produced by the transducers, the method comprising: attaching the sample material to at least one transducer in the transducer array; generating a selection signal which is to be applied to the transducer array in order select a desired one of the transducers and thereby obtain output from the desired one of the transducers; applying the selection signal to the transducer array; selectively enabling, based on application of the selection signal, a transmission path operatively coupling the desired one of the transducers with the output processing subsystem; and isolating the transducers within the transducer array, except for the desired one of the transducers, where such isolation is obtained by disabling transmission paths coupling such other transducers and the output processing subsystem, thereby substantially preventing output signals from being transmitted from such other transducers to the output processing subsystem.

8. Following my conception prior to September 30, 2002, I diligently worked toward reducing my inventions to practice, including close work in modeling and testing of the various embodiments, and frequent conversations related to the

drafting of the present application. On July 31, 2003, the present patent application was filed on my behalf.

9. All acts set forth herein and/or relied upon for the purpose of establishing invention prior to September 30, 2002 were carried out in the United States.

10. I declare that all statements made herein of my knowledge are true and all statements made on information and belief are believed to be true. These statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment or both under § 1001 of Title 18 of the United States Code. I understand that such willful false statements may jeopardize the validity of the application or any patent issuing therefrom.

Date: NOVEMBER 23, 2005

Daniel R. Blakley
Daniel R. Blakley

Invention Disclosure

[redacted]

PD No. 200206025	Date Received [redacted]	Managing Attorney [redacted]

General Information

Write a brief descriptive title of this invention.

Rupture Event Scanning Array Multiplexer.

Write a brief abstract of the invention.

This invention describes a transducer multiplexer capable of selection of transducers within an array, as used for Rupture Event Scanning. The multiplexers described are suitable for high frequency operation of transducer array configurations employed as Quartz Crystal Microbalances or for Rupture Event Scanning which support various modes of operation, including both impulse as well as continuous modes.

[redacted]

Attachments

Do you have electronic document files to upload? Drawings and diagrams will significantly enhance your invention disclosure. Please do not attach duplicative material that you have already included in this disclosure.

Note: All files that you attach will be converted into PDF format for review. Please do not attach executable files, videos, or large images that are not easily convertible. All MS Office files, PDFs, and text files are usually okay. Reviewers who review this disclosure will be looking for clarity and simplicity.

Inventor Information

Pursuant to my (our) employment agreement, I (we) submit this disclosure:

Daniel R Blakley | Hewlett-Packard Company | Corvallis

[redacted]

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Exhibit 1

[redacted]

Description of Invention

Explain the problems solved by the invention.

This invention enables the use of multiplexing in both Quartz Crystal Microbalances (QCM) as well as Rupture Event Scanning (RES). Both QCM and RES use single Piezo, Quartz, SAW, et al. transducers that are activated for sample analysis. Although previous art describes how to perform such analysis individually, it is desirable to construct arrays of these devices in order to enable accelerated analysis for multiple samples. In order to support the use of arrays of QCM or RES transducers, they must be activated or sequenced individually. In order to enable sequenced activation, a form of multiplexing must be employed. This invention teaches how to construct suitable multiplexers for an array of such transducers.

[redacted]

[redacted]

Describe the construction and operation of the invention.

The following describes the construction and operation of an array of transducers suitable for impulsed based Rupture Event Scanning, where an impulse is used to excite a transducer. Three variants of multiplexer architectures are described herein. Although each to may be able to support RES or QCM operation, each have associated features which make their selection preferable for continuous or impulse based RES operation.

In general, since it is required to provide a selection of input/output from a single (or dual) 'port' to an array of Piezo, SAW, et al. transducers. Functionally, the required operation is to multiplex or rather select the active transducer(s) from the overall array of what would normally be considered inactive transducers. But is also may be desirable to simultaneously terminate all 'non-selected' transducers into a low-impedance via the mux in order to minimize inadvertent excitation (both mechanical and electrical). Thus, the equivalent multiplexer function, which supports the above operation, must be to connect all transducers at once, those that are unselected to a load and those selected to a two-way transmission path, for the excitation and received transducer signals.

From a theoretical viewpoint, the mux may thus be viewed as a matrix, which has a unitary value for the selected transducer and a zero value for all unselected transducers. So given an input/output port, and a termination port, the matrix will always select the termination port for all transducers except the selected transducer, where the matrix connects with a unitary value.

From a practical viewpoint (as well as construction viewpoint) the matrix is much simpler than the theoretical view expressed above. Firstly, there are two configurations possible for connecting to each transducer. These are 'balanced' and 'unbalanced'. Where, unbalanced referrers to a transducer port having a "common" connection such as ground, and "unbalanced" having no common connection. The advantages of unbalanced are that of greater simplicity and lower cost due to the need to switch only one connection to a transducer port. The advantage of balanced is that of greater isolation from interfering ports as well as a higher potential transducer drive level available when differential drive excitation is employed.

Given the requirement to always connect a given transducer to either a load or the input/output port, a practical unbalanced multiplexer which would accomplish the above matrix function is constructed by an array of SPDT absorptive RF switches or in other words constructed as a set of switches comprising "T" between source and transducer. This RF switch architecture may be constructed using a variety of preferred technologies. Among these methods are CMOS RF transmission gates, nano-relays, and PIN diode (bulk switching) RF switches.

The T-type switch configuration, above, may be constructed as three SPST RF switches, or as a single SPDT RF switch. As a SPDT RF switch, the common connects to the transducer while one contact connects to the load (which connects to ground assuming the other connection of the transducer port also connects to ground), and the other switch contact connects to the input/output port. Alternately, if one where to employ 3 SPST RF switches, one would connect the I/O port to a

common node, the second would connect the common node to the load, and the third would connect the common node to the transducer. In operation, there are effectively two function states provided. These are the unity pass through state, where the 1st and 3rd switch are on with the 2nd off or the absorptive blocking state, where the 1st RF switch is off while the 2nd and 3rd are on. Other, more enhanced, versions of the T switch may be had for greater isolation by adding yet another switch in series with the 1st.

In summary, for an n x m Rupture Event Scanning (RES) array, the corresponding multiplexer array is also composed of n x m mux elements, where each element is configured as described above. Alternatively and as an enhancement for high frequency response, the array may be constructed as above but isolated into multiple sections, in a binary fashion, such as two sets of n/2 x m arrays, or 4 sets of n/4 x m arrays, etc. Although these options add additional switches, they may be employed to decrease the capacitive loading on the input/output port and thus may serve to improve signal integrity by preserving high frequency response.

Again, there is potential for the generalized alternative form of switching, where these multiplexed arrays are constructed of sets of T-type switches, configured without a common element such that both pins of a port are switched for balanced switching.

In general, due to the fact that the transducers are high impedance devices, and a multiplexing array is present, there is a potential for signal integrity degradation due to two factors within the array. These are transmission line reflections from the high impedance transducer (which would appear as an open circuit to each mux element switch), and the potential for variable transmission line reflections from each driving mux. to the common I/O port.

In order to address the above issues each multiplexer T type switch is located immediately adjacent to each transducer in order to minimize reflections due to a transmission line "Stub" effect. Further, each T-switch is located at a constant fixed distance with, respect to the transducer, throughout the array in order to minimize reflection variability.

Thus the transducer array is constructed as a regular array of transducers where adjacent to each transducer is the equivalent of a RF SPDT absorptive switch. This switch appears (and functions) as a unity gain high-impedance port when connected to the transducer and a high impedance when disconnected from the transducer. Thus, in both cases it is high impedance or appears as an open circuit to the source.

Again in order to construct an array of multiplexed transducers with fairly consistent characteristics, each absorptive SPDT RF switch is selected by a crossbar decoder matrix with all individual RF ports connected in parallel. Alternatively, breaking the array into divisions where successive switches isolate succeeding switches, thus minimizing the capacitive loading on the I/O port, may isolate the switches.

The multiplexer is operated by selecting the transducers to excite (through a serial or parallel control scheme, then applying an impulse to the input of the mux. The output of the mux is received on the same I/O pin for analysis.

It should be mentioned that there is yet another array multiplexing method for impulse based Rupture Event Scanning, which has some, advantages over the method described above. In essence, this method is construct an array of transducers, each with their own local impulse generator or gated oscillator monolithically constructed adjacent to each associated transducer. The advantage of this configuration is that the excitation impulse does not have to be routed across the die but rather only the control signals as well as the output of the transducer. Also, since the output of the transducer may be transformed into a low impedance source (through an amplifier) routing complexities and noise/crosstalk issues may be minimized.

For construction of the integrated transducer impulse generator, the generator may be a step recovery diode pulse generator with controls for amplitude and pulse duration where the circuitry is replicated for each transducer. Advantages of this approach include the avoidance of transmission line effects

over the die with the necessity to only mux the transducer's output response.

The following describes the construction and operation of an array of transducers suitable for Continuous Rupture Event Scanning, where an increasing amplitude signal is used to excite a transducer.

Unlike the transducer array described above, which was suitable for impulse based RES, the Continuous Rupture Event Scanning multiplexer has a separate input port and output port to the array. This is because, to maintain consistency, each array transducer requires its own local oscillator, in order to avoid the capacitive and inductive variations, which are attendant with a multiplexed common oscillator. Nevertheless, multiplexing is still required for this architecture.

For each transducer, with its associated oscillator, multiplexing is performed for two functions: the multiplexing of the "oscillator enable" as well as the multiplexing of the oscillator output. Here each oscillator enable is simply an on/off signal that enables each oscillator. The oscillator enable may be a simple transistor which when enabled connects one contact of the transducer port to the oscillator's common ground pin. Further the multiplexing of the oscillator's output signal may be accomplished either balanced or unbalanced (similar to that described previously) where the unbalanced case is simply the output enabled to feed a common output port.

Preferentially, these multiplexing functions are connected together to a common decoder. The multiplexer decoder may be programmed through a parallel or serial means, but in either case the decode selection word, decodes to a one of n where only one oscillator (or oscillator set) is enabled, with all others being disabled. Either Binary or Gray Scale (or et. al.) decoding may be employed. Thus for an array of N x M transducers, selection proceeds as a one of n x m decode. Preferably, selection is serial in order to minimize pads and interconnects on the array, where one of two decode methods may be employed. Firstly, a serial to parallel shift register may be employed where the output of the shift register then feeds a decoder. Alternatively, a digital state machine may perform the decoding directly.

It should be mentioned that common to each oscillator must include a control for oscillator amplitude excitation for the transducer. This amplitude is selected through a digital to analog converter, where the digital inputs may be controlled either a serial data stream or, alternatively, parallel controls inputs for higher speed scanning.

Preferentially, and in summary, very few connections are required for the continuous rupture event-scanning array. These include the output port, the serial control input data stream, which contains serial data clock, multiplexer control, and amplitude control.

Moreover, in order to facilitate faster amplitude programmability, for the anticipated RES modes, it is preferable to support the following signals: reset amplitude counter, increment amplitude counter, and serial load amplitude counter.

In operation, for Continuous Rupture Event Scanning, a serial data stream, containing transducer selection, is fed to the transducer. Amplitude is programmed by asserting an amplitude reset command (or alternatively, by programming a starting value). Then the transducer is selected and its oscillator enabled. The output multiplexer routes the oscillator's output port signal to the monolithic array's output port, where it is demodulated and analyzed. Further, as the signal analysis and control unit completes each individual analysis, it issues an increment command (or signal) to the amplitude control output multiplex until a scan is completed. When RES is completed, a new transducer is selected and the above process repeats.

What are the advantages of this invention over what has been done before?

The advantages of this invention over what has been done before lies in enabling arrays of QCM or RES transducers to be constructed and used for sequenced individual activation. The availability of arrays of transducers for QCM and RES, which may be selectively sequenced, significantly enables

more rapid molecular, biological, or viral analysis to occur when compared with methods previously available.

Invention History

[redacted]

When was this invention published externally?

Describe the details of the external publication of this invention

[redacted]

Specify date of announcement or planned announcement.

Describe the details of the announcement of this invention.

[redacted]

Was the invention disclosed under a Confidential Disclosure Agreement?

Date this invention was or will be disclosed:

Describe the details of the disclosure of this invention. To whom will/has it been disclosed?

[redacted]

[redacted]

[redacted]

When was this invention built?

[redacted]

Give the agency and contract number:

Witnesses

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Additional Information

Enter one or more keywords which best characterize this disclosure. These keywords will help researchers find your disclosure after it is submitted.

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What is the PD Number of the disclosure this one is related to?

[redacted]

Administrative Record

Date and time when this invention disclosure was submitted

[redacted]

[redacted]

Record the PD number assigned by Merlin to this invention disclosure.

200206025

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Tracking Information

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